

An unusual opportunity for epidemiological study of an outbreak of gastroenteritis was afforded when 171 campers became ill within a 30-day period at a Boy Scout ranch in New Mexico.

Outbreak of Nonbacterial Gastroenteritis at a Boy Scout Ranch

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NONBACTERIAL gastroenteritis is a self-limited disease characterized by an abrupt onset of nausea, vomiting, diarrhea, and abdominal cramps. The illness may appear sporadically or in epidemics. Most of the knowledge regarding this disease has been derived from studying outbreaks occurring in institutional populations (1-6).

During August 1957, an outbreak of gastroenteritis affecting 171 persons was observed on a Boy Scout ranch in New Mexico. The disease was similar to those previously described as epidemic diarrhea and vomiting or infectious nonbacterial gastroenteritis. This outbreak presented an unusual opportunity to study the disease from two standpoints: (a) to observe the behavior of the disease in four separate susceptible groups of people who came into the area at weekly intervals, and (b) to observe the occurrence of the disease in family constella-

tions. Clinical and epidemiological observations were made in these well-defined populations, and isolation of the virus was attempted.

The Setting

The Boy Scout ranch occupied an area of approximately 177,000 acres in the Sangre de Cristo Mountains. There were three major population centers designated as ranch headquarters, camping headquarters, and training center. The units were located approximately one-fourth to one-half mile apart. Ranch headquarters carried on the administrative affairs and served as the central depot for food, camping supplies, and other general items. After arriving at the ranch, Boy Scouts were quartered in tents at camping headquarters for 1 or 2 days prior to leaving on various camping expeditions in the mountains for the duration of their stay. During the months of June, July, and August, Scout leaders were given special training in the training center for 1 week to enable them to instruct local Scout heads in their respective communities. Tent homes were supplied for their families. Each Wednesday approximately 350 people entered the center and departed the following Tuesday by noon. Also living in the center were 86

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staff members and their families, 76 of whom were employed for the entire 13 weeks and 10 for shorter periods.

The training center consisted of 186 tents each measuring 10 by 12 feet. Each tent was occupied by two persons. Parents and children usually occupied adjacent tents. Occasionally crowding made it necessary for parents to share a tent with one of their children. Also located in the training center were a number of permanent buildings for staff, residences, offices, dining hall, assembly hall, recreation hall, and infirmary. A few campers were housed in private cottages.

The tent area was divided into three parts designated as north tent city, south tent city, and south tent city east end. For ease in identification, these areas will be referred to here as A, B, and C, respectively. Each tent city had accommodations for more than 100 persons. General sanitation was excellent, and each tent city had separate modern lavatory facilities. All foods were prepared in a central kitchen. Residents of cities B and C shared a mess hall, but residents of city A ate in a separate dining area. Staff members ate in either mess hall, as they preferred.

The water used in all parts of the ranch came from a central processing plant. The raw water from the reservoir, formed by damming a creek, was treated by flocculation, sedimentation, and filtration. The purified water was chlorinated to contain 0.4 part per million of available chlorine, and daily records were kept of the tests performed on water samples from various sites on the ranch. Chlorine residuals were adequate during the entire period, and there was no evidence of gross contamination of the water supply.

All foods were obtained from a central commissary. The meat products came from a commercial packer, and pasteurized milk, supplied by a single distributor, was used in all areas.

Sewage from the camp headquarters and the training center was treated in Imhoff tanks, and the primary effluent, after being chlorinated, was further treated by subsurface filtration. Sewage from the ranch headquarters received no primary treatment before emptying into a ditch which drained into an area about one-half mile away.

A medical staff of one physician, three medical students, and two nurses served the ranch population.

Study Methods

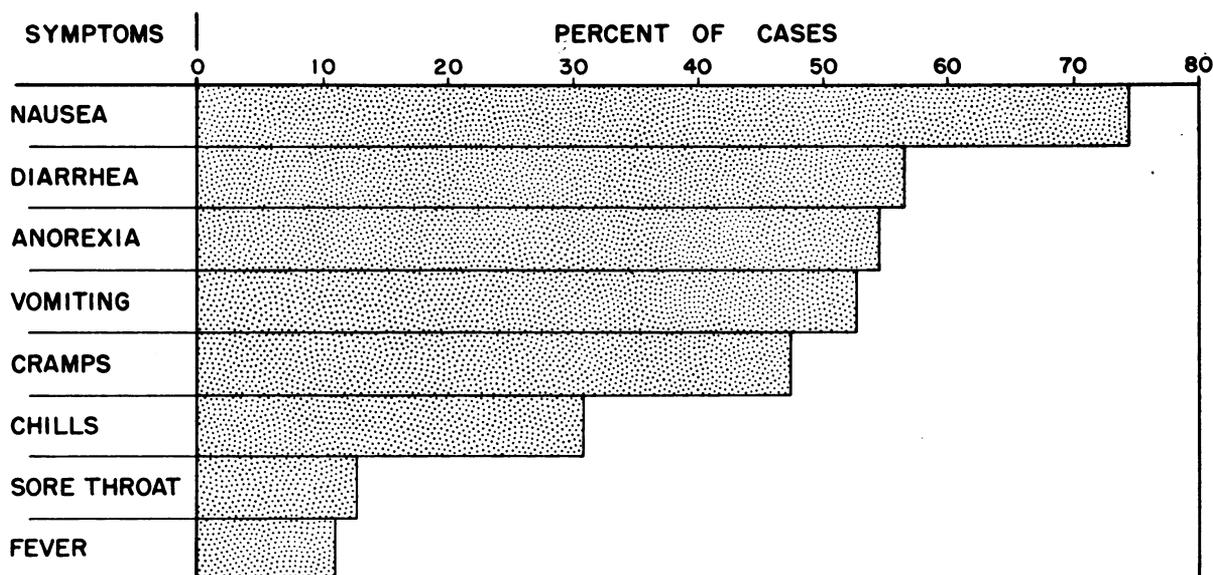
A systematic investigation was initiated on August 21, 1957, 21 days following the beginning of the outbreak, and terminated on August 27. All patients and their familial associates were interviewed and the data were recorded on standard questionnaire forms. All ill persons, upon reporting to the infirmary, were examined by Dr. Foley or by the medical students. Daily records were kept on all persons reporting to the infirmary for treatment. Prior to August 20 a daily logbook was maintained by the nurse in which she listed all persons reporting ill to the infirmary, together with a description of their major symptoms. These records were available for the previous 2 years (table 1).

Specimens for etiological studies, consisting of feces (stools or rectal swabs), oropharyngeal secretions (throat washings or swabs), and acute and convalescent serums were obtained from reported cases and their familial contacts.

Table 1. Reported incidence of gastroenteritis by month, Scout training center in New Mexico, 1955-57

Year	June			July			August		
	Total population	Number ill	Percent ill	Total population	Number ill	Percent ill	Total population	Number ill	Percent ill
1955.....	1, 020	10	1. 0	1, 040	13	1. 3	1, 030	5	0. 5
1956.....	1, 006	7	. 7	1, 016	3	. 3	1, 020	7	. 7
1957.....	956	10	1. 1	1, 100	24	2. 2	1, 459	171	11. 7

Figure 1. Frequency of symptoms among 55 cases of gastroenteritis, Scout training center in New Mexico, August 1957



Feces and oropharyngeal specimens for viral studies were frozen at -20°C . or -70°C . Feces for bacteriological examinations were preserved in glycerine without refrigeration. Some of the specimens frozen at -20°C . were also studied for the presence of bacterial pathogens. Serums, after being separated from the clots, were stored at -20°C . Since the campers came from all parts of the country, it was not possible to follow them for subsequent illness after they left camp. However, convalescent serums were obtained from certain families.

Bacteriological studies were performed by the laboratory of the New Mexico Department of Public Health, using standard methods for isolation of enteric pathogens. Viral studies were performed in this laboratory using standard tissue culture techniques. The tissue cultures used were HeLa, human amnion and KB cells, and epithelial cells from monkey, guinea pig, and calf kidneys. One-day-old suckling mice were also used. All specimens were passed in suckling mice and monkey kidney epithelial cells at least once. Five to eleven representative specimens were passed two or more times in each of the tissue culture systems except that only primary passage was made in guinea pig epithelial cells. Specimens were examined also for the presence of hemadsorption viruses using

the technique developed by Chanock and associates (7). Guinea pig and chicken red blood cells were used in the test performed at a pH range of from 6.5 to 8.

Bacteriological and toxicological studies were performed on water samples collected from outlets at various sites on the ranch during the latter part of August.

Clinical Observations

The predominant symptoms were nausea, vomiting, diarrhea, and abdominal cramps. The onset was generally sudden; however, in some instances there were prodromes of malaise or slight nausea for a few hours. The sudden onset of vomiting or diarrhea usually ceased as quickly as it started. The patient felt quite well shortly thereafter, but in most cases another bout of vomiting followed 1 to 4 hours later.

The frequency distribution of individual symptoms observed in 55 patients is illustrated in figure 1. The most common symptom was nausea, which affected about 75 percent of the patients. More than half of the patients had diarrhea and vomiting. Vomiting was observed almost twice as frequently in children as in adults. Abdominal cramps occurred in about 47 percent, but chills and sore throat were less

frequent complaints. Fever, with temperature ranging from 99.5° to 101° F., was observed in about 10 percent of the patients, although none was dehydrated. There was considerable variation in the severity of the disease.

Of the 55 patients, 17 had both vomiting and diarrhea, 12 had vomiting without diarrhea, 15 had diarrhea without vomiting. The remaining 11, who had neither vomiting nor diarrhea, had varying complaints but mainly nausea, abdominal cramps, and chills. The stools varied in consistency from pea soup to poorly formed; the frequency of bowel movements ranged from 2 to 25 times per day, with a median of 3. No pus or blood was seen grossly or microscopically. On physical examination, no remarkable abnormality was found. About 10 percent of the patients showed moderate injection of the pharynx, but this finding is probably the result of normal variations in random sampling. Hyperactive bowel sounds were evident on abdominal auscultation.

The average duration of illness was less than 24 hours, although some of the patients were ill for as long as 3 days. The duration of the illness was longer and the symptoms were somewhat more severe in adults than in children. Recurrences of the illness after recovery were uncommon. No deaths or complications were noted during the period of observation.

White blood counts were obtained on five children and five adults. The counts varied from 7,500 to 22,800 per cubic millimeter, with a median of 13,200. The number of leukocytes per cubic millimeter was higher in children than in adults, and the higher counts were associated with an absolute increase in the number of polymorphonuclear leukocytes.

Epidemiological Studies

An increase in the incidence of gastroenteritis was observed during the first week of August 1957, and abnormally high rates continued until the camp closed in the first week of September. The first case of gastroenteritis was noted, among a new group of persons who arrived on July 31, in a 2½-year-old child who became ill approximately 3 hours after arrival. On the following day, a similar illness was noted in a 5-year-old sibling of this child. On

the third day, five additional cases were observed among other families living in the same area.

Of 1,457 persons attending the Scout camp for 1 or more weeks during the month of August, 171 experienced an attack of gastroenteritis for an overall attack rate of 12 per 100 persons. This rate was considerably higher than the rates of the preceding months of June and July (table 1). Although the rate observed for July was higher than that of June or any other month during the preceding 2 years, the illnesses observed were scattered at random throughout the month with no abrupt peaking of cases in any one week. It appears, therefore, that the slight increase in incidence of gastroenteritis during July probably represents variations in seasonal incidence rather than cases occurring during the early phase of the outbreak in August.

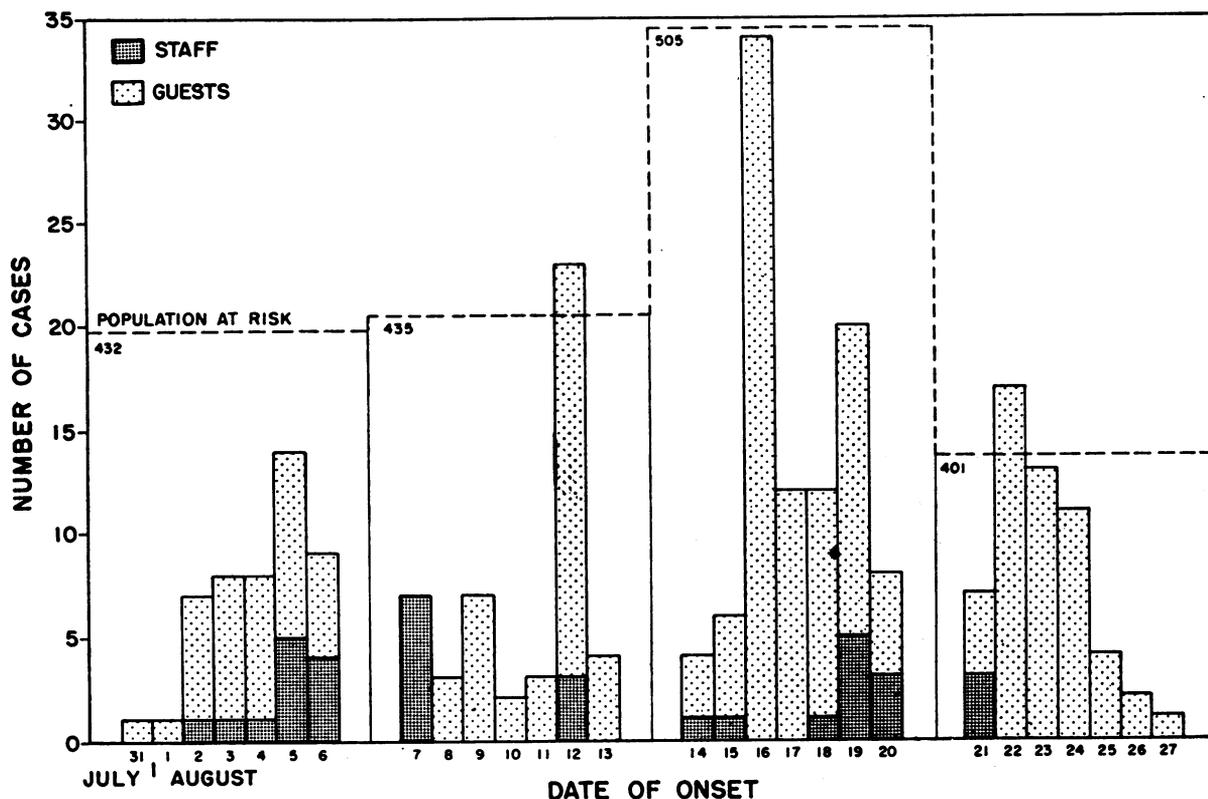
The weekly incidence of gastroenteritis observed among campers staying only 1 week between July 31 and August 27, 1957, is shown in table 2. The attack rates ranged from 9 to 16 with an average of 12 per 100 persons. The highest rate was observed during the third week, when there was the greatest camp population. Attack rates were significantly higher among staff members and members of those families staying at the camp for at least 2 weeks. The rate for the staff members was 42 per 100 persons (36/86) and that for families staying at the camp for 2 weeks was 40 per 100 persons (33/58).

Table 2. Weekly incidence of gastroenteritis occurring at Scout training center in New Mexico, 1957

Week ending	Number persons	Number ill	Attack rate (percent)
August 6-----	342	35	10
August 13-----	357	33	9
August 20-----	406	63	16
August 27-----	295	33	11
Total-----	1,400	164	12

NOTE: Each weekly population represents a new group of susceptibles. Staff personnel and families in cottages were not included. 58 persons staying from the third to fourth week were not included in the fourth group.

Figure 2. Incidence of reported cases of gastroenteritis by date of onset, Scout training center in New Mexico, July 31–August 27, 1957



The number of persons reporting to the infirmary for diagnosis and treatment classified by date of onset of illness is illustrated in figure 2. It should be recalled that each weekly population at risk represented a new group of susceptibles, with the exception of the staff members and the group of families which remained over from the third to the fourth week of camp.

More than half of the illnesses in the first three groups occurred toward the end of the week, but the concentration of illness in the fourth group was observed during the first part of the week. The difference in the epidemic pattern observed in the fourth group may be partially explained by the fact that 58 persons who entered the camp during the third week remained

Table 3. Weekly incidence of gastroenteritis by tent city, Scout training center in New Mexico, 1957

Week ending	City A		City B		City C	
	Number persons	Percent ill	Number persons	Percent ill	Number persons	Percent ill
August 6	132	5	119	20	91	6
August 13	141	8	120	13	96	6
August 20	158	15	136	24	112	6
August 27	141	11	87	10	67	10
Total	572	10	462	18	366	7

NOTE: Each weekly population represents a new group of susceptibles. Staff personnel and families in cottages were not included. 58 persons staying from the third to fourth week were not included in the fourth group.

Table 4. Weekly incidence of gastroenteritis in tent cities by major age groups, Scout training center in New Mexico, 1957

Week ending	Under 18 years			18 years and over			Total		
	Popula- tion	Num- ber ill	Percent ill	Popula- tion	Num- ber ill	Percent ill	Popula- tion	Num- ber ill	Percent ill
August 6.....	167	26	16	175	9	5	342	35	10
August 13.....	190	15	8	167	18	11	357	33	9
August 20.....	186	34	18	220	29	13	406	63	16
August 27.....	139	18	13	156	15	10	295	33	11
Total.....	682	93	14	718	71	10	1,400	164	12

over during the fourth week; 10 of these 58 persons became ill during the first 2 days of the fourth week. Thus it was entirely possible that these 10 cases served to spread the disease widely among persons in the fourth group so that there were almost no susceptible persons by the middle of the week.

Shown in table 3 are the attack rates by tent city for each of the 4 weeks. During the first 3 weeks the incidence was significantly higher among persons living in city B than those living in the other two tent cities. During the fourth week the attack rates in persons living in the three tent cities were approximately the same. It is noteworthy that when the space between occupied tents in city B was increased during the fourth week, the incidence of gastroenteritis declined to that approximating those of the other tent cities.

Attack rates by age for the four groups are summarized in table 4. Incidence per 100 persons among those under 18 years of age was 14 as compared with 10 among those 18 years of age and older ($P=0.02$). This difference was particularly evident in the first group (week ending August 6), in whom the rate among children was more than three times that among adults. There was no difference in the sex distribution.

Multiple cases in families were common. The secondary attack rate among 371 familial contacts of those families staying only 1 week at the center was 15.4 per 100 persons. The average secondary attack rate among the families of staff members and families staying in the center for 2 weeks was significantly higher than that of the former group; of the 43 famil-

ial contacts in the latter group, the secondary attack rate was 37 per 100 persons.

All but 4 of the 57 secondary cases observed in families staying only 1 week at the center developed within 2 days after onset of the index case. Since the time interval between onset of first and secondary cases was so short, it is difficult to say whether these secondary cases were true secondary illnesses or whether they were co-primary cases acquired from the same source as the primary cases. Seven secondary illnesses in staff families occurred within 48 hours of the primary case.

Etiological Studies

Stools obtained from 11 patients were examined for presence of pathogenic bacteria and parasites. Enteric pathogens were not detected in any of the specimens.

Specimens obtained from 27 individuals were examined for the presence of viral agents. These consisted of 20 throat washings and 29 fecal specimens. All the specimens were tested in suckling mice and in various tissue culture systems mentioned previously. A total of four viral agents were isolated from two persons of the same family by inoculation of specimens into suckling mice. Two of the agents came from throat washings and the other two from fecal samples. The agents, although not definitely identified, probably were Coxsackie viruses of group A. All four agents, when inoculated into suckling mice, caused flaccid paralysis followed by death. Histologically extensive degeneration of the skeletal muscles was noted, with no lesions found in other or-

gans. Neither 3-week-old mice nor various tissue cultures, including monkey kidney epithelial cells, HeLa cells, and human amnion cells were affected by the agents.

Cytopathogenicity was not observed in any of the tissue culture systems following inoculation of a selected number of specimens. A total of 28 specimens inoculated into monkey kidney epithelial cells and 25 specimens into calf kidney epithelial cells were tested for the presence of hemadsorption virus. No hemadsorption was observed under the conditions previously mentioned over a period of observation varying from 7 to 40 days.

Ten water samples obtained from outlets in various areas on the ranch during the course of the epidemic were tested for bacterial contamination. Coliform organisms were not detected in any of the samples. Also, two water samples tested did not reveal excessive amounts of inorganic compounds normally found in water or other inorganic substances that are capable of causing diarrhea.

Discussion

The clinical entity referred to as acute infectious nonbacterial gastroenteritis is an exceedingly common disease. It has been found by Hodges and associates (8) in a family study that gastrointestinal disorders are second in incidence to respiratory diseases. Gastrointestinal disorders consist mainly of cases of acute infectious nonbacterial gastroenteritis.

This disease usually begins abruptly with anorexia, nausea, vomiting, and diarrhea in varying combinations. Headache, fever, and leukocytosis may occur in some instances. On physical examination the distended colon can often be palpated and borborygmi can easily be heard. The disease is self-limited and of short duration. The more severe cases, particularly those in the older age group, may be complicated by dehydration, collapse, and, rarely, death (4, 5, 9). Although this disease may occur throughout the year, the peak incidence is in the fall and winter months.

The clinical picture observed in the present outbreak is consistent with that of acute infectious nonbacterial gastroenteritis as reported in other studies (1-6, 9). It is notable that

about 10 percent of the patients observed in this outbreak complained of sore throat. Whether these symptoms represent an integral part of the clinical picture of nonbacterial gastroenteritis or whether they merely represent a coincidental finding is difficult to determine, although several workers (2, 10, 11) have reported an increase in frequency of throat symptoms. Symptoms related to the respiratory system were not observed in this study. Fever was present in about 10 percent of the cases.

Attack rates among persons attending this camp were considerably lower than those reported in outbreaks of similar illnesses. The frequency of illness was undoubtedly related to the duration of exposure and the duration of observation. The incidence of gastroenteritis among campers staying 2 weeks and the permanent staff was more than three times higher than it was among campers staying 1 week. The attack rates in the former groups corresponded well to those reported in other outbreaks (6, 12) in which the period of observation was longer than 1 week. This relationship was reflected also by the secondary attack rates observed among family contacts. Secondary attack rates among campers would undoubtedly have been higher if it had been possible to follow the patients after they left camp. In a similar study made by Smillie and his co-workers (12), the secondary attack rate was found to be 43.7 per 100 persons. This rate was slightly higher than that observed in the families of staff members and in families staying 2 weeks at the camp.

Nonbacterial gastroenteritis is probably caused by a number of different viral agents. The assumption that some of the outbreaks described in the literature were due to viral agents is based on studies performed on human volunteers using fecal filtrates from patients with nonbacterial gastroenteritis as inoculums. Two immunologically distinct agents have been delineated, namely, the so-called Marcy and FS strains. The Marcy strain was isolated from a typical outbreak of gastroenteritis which occurred at Marcy State Hospital near Utica, N.Y., in 1946 (9); the FS strain was isolated from a patient with nonbacterial gastroenteritis

by Jordan and associates (13) in their Cleveland family study. Although these strains have been incriminated as etiological agents of nonbacterial gastroenteritis, they have not been cultivated as yet in the laboratory using various laboratory animals, media, and tissue culture cell lines (12,14-16).

The etiological agent causing this outbreak remains undetermined. The four Coxsackie-like viruses recovered from two members of a family undoubtedly represent coincidental findings and are not the principal cause of the outbreak. Pathogenic bacteria and amebas were excluded as causative agents on the basis of negative stool examinations and on the basis of clinical and epidemiological studies. The possibility that excessive amounts of inorganic substances were present in the drinking water was eliminated by appropriate tests performed on water samples collected from various points in the camp.

The mode of transmission of viral gastroenteritis has been a subject of considerable research. Early in the experimental work with human volunteers, Reimann and associates (17) reported that they were successful in transmitting the disease by aerosol spray with fecal filtrate obtained from patients with gastroenteritis. However, these investigators were unable to induce the disease in volunteers by ingestion of the same filtrate. Since that time, several other groups of workers (9,13,18,19) have successfully transmitted the disease by feeding bacterial-free fecal filtrates to human subjects although no one has been able to confirm Reimann's original report relating to respiratory transmission. While it may be possible to transmit nonbacterial gastroenteritis by the respiratory route, the above experimental evidence seems to favor the fecal-oral route as the principal mode of transmission.

The data presented here are insufficient to establish whether the present outbreak was transmitted by the fecal-oral or respiratory route. It is quite certain, however, that the principal mode of transmission is by person-to-person contact. There was no evidence that the outbreak was caused by a common source either on the basis of the epidemiological data or on thorough examination of the water, milk, and food supply.

Summary

An outbreak of gastroenteritis affecting 171 of 1,457 persons occurred at a Boy Scout ranch during a period of 1 month. The clinical characteristics were similar to those described in acute infectious nonbacterial gastroenteritis. Four separate susceptible groups were involved in the epidemic. The attack rates varied from a low of 9 percent in campers staying 1 week to a high of 42 percent in staff members. Attack rates were significantly higher in children. Multiple cases in families were commonly observed. Secondary family attack rates varied from 15.4 percent in those families staying 1 week to 37 percent in the staff families and campers staying more than 1 week.

Laboratory studies for enteric pathogens were negative. Viral studies using suckling mice, various tissue culture lines, and hemadsorption techniques failed to uncover an etiological agent.

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Symposium on Venereal Diseases

The 11th Annual Symposium on Recent Advances in the Study of Venereal Diseases will be held April 7 and 8, 1960, in the Palmer House, Chicago, Ill. The sessions are open to all physicians and workers in this and allied fields who are interested in the venereal diseases.

Sponsored jointly by the American Venereal Disease Association and the Public Health Service, the symposium will follow a venereal disease seminar for public health personnel which begins April 4.

Persons wishing to present scientific papers on subjects related to venereal diseases should mail preliminary abstracts before November 25, 1959, to Dr. William J. Brown, Program Committee Chairman, in care of the Venereal Disease Branch, Communicable Disease Center, Public Health Service, 50 Seventh Street, NE., Atlanta 23, Ga. These abstracts should give information sufficient to assist the program committee in making a decision as to acceptance or rejection of the papers. Authors of accepted papers will be notified before January 15, 1960. Final abstracts not exceeding 500 words will be required by March 1, 1960.